REMARKS

Favorable reconsideration of the above-identified application, as presently amended, is respectfully requested. The Final Office Action of March 22, 2002 contained the following rejections:

1. Claims 1-3, 6, 8-11 and 21-37 were rejected under 35 USC 103 as being unpatentable over **Fox** et al. (U.S. Patent No. 5,285,347) in view of **Hamilton** et al. (U.S. Patent No. 5,901,037);

2. Claim 4 was rejected under 35 USC 103 as being unpatentable over **Fox** in view of **Hamilton**, and further in view of applicant's admission of known/conventional prior art.

Each of these will be addressed in turn.

1. Rejection of Claims 1-3, 6, 8-11 and 21-37 under 35 USC 103

Applicant has amended independent claims 1 and 21, as well as dependent claim 2. Claim 2 has been amended to define the formation of the first and second seal. Support for these amendments can be found at least in Figure 1 and on page 7 of the specification. No new matter has been added.

Independent claims 1 and 21 now contain the inventive elements of: 1) the microtubes and low profile unitary member are comprised of the same piece of metal; 2) the microtubes are fluidly interconnected to adjacent and non-adjacent microtubes via the end caps; and 3) the low profile unitary member has a first and second seal at the first and second end caps, respectively.

Applicant respectfully submits that **Fox** in view of **Hamilton**, alone or in combination, does not teach, suggest these features. In fact, there is no suggestion anywhere in **Fox** or **Hamilton** that the references should be modified in a manner required to arrive at the invention as claimed.

Neither **Fox** nor **Hamilton** teach or suggest that the hybrid heat sink 20 disclosed in **Fox** be comprised of the same piece of metal that forms the cavity 16. In fact, **Fox** teaches away from such a construction: "It may be appropriate to cast the hybrid heat sink 20 in two sections and join the sections along line 40 by a brazing or soldering process." Col. 5, ll. 49-51. The alternate configuration referred to in **Fox** requires the addition of flexible tubing: "Flexible tubing 90 is then attached to the fittings, thereby allowing a path for the fluid to flow through the hybrid heat sink 20." Col. 5, ll. 62-64.

Neither **Fox** nor **Hamilton** offer a suggestion that the mictrotubes and heat exchanger in the figures of **Hamilton** referenced by the Examiner (Figs. 12 and 13) be composed of the same piece of metal. In fact, in the only figures of **Hamilton** which disclose structure the amplifier 10 is "comprised of a plurality of transistor dies 12, each including multiple transistors, not shown, connected in parallel. The dies 12 are mounted on a substrate 14 which may be, for example, silicon or other semiconductor material." Col. 3, ll. 38-43; *see also* Fig. 10, which shows two components forming the microchannels (26 and 14). The present invention, as claimed, has a unitary member having microtubes, both the unitary member and the microtubes being formed of the same piece of metal. The art cited by the Examiner teaches away from such a unitary construction.

Neither **Fox** nor **Hamilton** disclose adjacent and non-adjacent fluid communication between microtubes. **Fox** teaches that "the cavity travels in a serpentine path in a plane that is parallel to the upper and lower surfaces of hybrid heat sink 14." Col. 5, ll. 43-45. The serpentine path cannot suggest adjacent and non-adjacent fluid interconnectivity of the microtubes. **Fox** therefore teaches away from the claimed invention in this regard. The embodiments of Figure 1 and Figure 2 support this conclusion, as clearly neither provides for both adjacent *and* non-adjacent fluid interconnectivity of the cavity, or the microtubes of **Hamilton** as modified by the Examiner.

Likewise, **Hamilton** teaches away from fluid communication between adjacent and non-adjacent microtubes. In fact, the input valve 46i and output valve 46o provide resistance to flow from occurring between adjacent and non-adjacent microtubes at least at the input end of the substrate of **Hamilton** "Thus what has been shown and described is a passive pyramidic microchannel valve which relies on the geometry of the tapered passage to create *a greater flow resistance in the negative direction*." Col. 5, ll. 21-24 (emphasis added). Therefore one of the express teachings of **Hamilton** is to keep flow moving in one direction and prevent fluid communication between adjacent and non-adjacent microtubes.

The claimed invention represents a patentable improvement over the prior art which, in addition to the above discussed structural differences, provides several advantages. The present invention is much less expensive than the references applied by the Examiner. The present invention allows greater heat transfer through the use of a single piece of metal. The present invention allows greater thermal communication through the fluid interconnectivity of the adjacent

and non-adjacent microtubes. The present invention is more reliable by being enclosed only at respective ends of the member. These favorable characteristics are not found in the prior art.

Accordingly, it is respectfully submitted in view of the above amendments that the independent claims in the present application are in condition for allowance, and all other dependent claims are submitted to be allowed as they include the limitations of the independent claims from which they depend.

2. Rejection of Claim 4 under 35 USC 103 in view of applicant's admission

As claim 4 depends from independent claim 1 addressed abaove, claim 4 is respectfully submitted to be in condition for allowance over **Fox** in view of **Hamilton.**

Furthermore, applicant disagrees with Examiner's characterization of "conventional thermal interface material" to include the metal plating material of claim 4. It is well understood in this art that "thermal interface material" refers to substances such as W.L. Gore and Associates, Inc.'s POLARCHIP™ (flouropolymer composites that consist of an ePTFE matrix filled with Boron Nitride particles), Thermalloy, Inc.'s Thermalcote II (Non-Silicone Thermal Joint Compound), Stockwell Rubber Company's thermal management components (low durometer Silicone or compressible sponge), and thermal greases in general. In that regard, Applicant has provided Applicant's attorney with the specimen attached as Exhibit A, comprising advertising for such materials. Such products and thermal greases in general are well known to a man of the art to be "conventional thermal interface material."

It is believed that entry of this Amendment is warranted under the provisions of 37 C.F.R. § 1.116 as it clearly causes the claims active in this application to be allowable over the art of record. Accordingly, it is believed that entry of this Amendment is warranted under the provisions of 37 C.F.R. § 1.116.

In view of the foregoing, Applicant respectfully requests the thorough reconsideration of this application and earnestly solicits an early notice of allowance.

Respectfully submitted,

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Clean set of pending claims after response filed to March 22, 2002, final office action:

1. (Thrice amended) A cooling apparatus for removing heat from at least one heat generating component, said cooling apparatus comprising:

a low profile metal unitary member comprised of one piece of metal, said low profile unitary member having a first exterior surface adapted for receiving heat from the at least one heat generating component and having a plurality of micro tubes formed of said one piece of metal having a flattened heat transfer surface, said low profile metal unitary member having a micro tube inlet comprised of said one piece of metal and a micro tube outlet comprised of said one piece of metal, said low profile metal unitary member providing an entirely metallic thermal path for conducting heat from said first exterior surface to a heat transfer fluid contained within said plurality of micro tubes;

an inlet tube;

an inlet end cap interconnecting the micro tube inlets in fluid communication and connecting the micro tube inlets in fluid communication with said inlet tube;

an outlet tube;

an outlet end cap interconnecting the micro tube outlets in fluid communication and connecting the micro tube outlet in fluid communication with said outlet tube;

said low profile metal unitary member being sealed by a first seal and a second seal for enclosing said low profile metal unitary member, said first seal being formed at said inlet end cap, said second seal being formed at said outlet end cap, said first seal forming a first seal length and said second seal forming a second seal length;

each of said plurality of microtubes being fluidly connected to adjacent and non-adjacent microtubes via said inlet end cap and said outlet end cap;

means for circulating said heat transfer fluid through said inlet tube, said inlet end cap, the plurality of micro tubes of said low profile metal unitary member, said outlet end cap, and said outlet tube; and

means for removing heat from said heat transfer fluid.

2. (Twice Amended) The cooling apparatus of claim 1, wherein said first seal and said second seal are formed by welding.

3. (Amended) The cooling apparatus of claim 2, wherein said member is in thermal contact with said at least one heat generating component, and said member is further in direct contact with said heat transfer fluid.

4. (Amended) The cooling apparatus of claim 2, wherein said low profile metal member is plated on an exterior surface with a metal material.

5. The cooling apparatus of claim 1, further comprising at least one thermoelectric cooling unit disposed between said at least one heat generating component and said first exterior extrusion surface.

6. (Amended) The cooling apparatus of claim 1, wherein said low profile metal member further comprises a plurality of fins on a second exterior surface opposite said first exterior surface adapted for receiving heat.

7. (Amended) The cooling apparatus of claim 1, wherein said low profile metal member further comprises a plurality of fins or grooves on an interior surface of each of said plurality of micro tubes.

8. (Amended) A cooling apparatus for removing heat from at least one heat generating component, said cooling apparatus comprising:

a low profile unitary member having a flattened exterior extrusion surface adapted for receiving heat from the at least one heat generating component and a plurality of micro tubes with a micro tube inlet and a micro tube outlet;

at least one fin on an interior surface of at least one of said plurality of micro tubes;

means for circulating a heat transfer fluid through said plurality of micro tubes of said low profile member; and

means for removing heat from said heat transfer fluid.

9. The cooling apparatus of claim 8, wherein each of said micro tubes are substantially rectangular in shape.

10. (Amended) The cooling apparatus of claim 8, wherein said low profile member is formed of a metal material.

11. The cooling apparatus of claim 10, wherein said metal material is in thermal contact with said at least one heat generating component, and said metal material is further in direct contact with said heat transfer fluid.

12. The cooling apparatus of claim 8, further comprising at least one thermoelectric cooling unit disposed between said at least one heat generating component and said first exterior extrusion surface.

13. (Amended) The cooling apparatus of claim 8, wherein said low profile extrusion further comprises at least one fin on an interior surface of each of said plurality of micro tubes.

21. (Twice Amended) A cooling apparatus for removing heat from at least one heat generating component, said cooling apparatus comprising:

a low profile metal unitary member comprised of one piece of metal having a first exterior extrusion surface adapted for receiving heat from the at least one heat generating component and a plurality of micro tubes with a micro tube inlet comprised of said one piece of metal and a micro tube outlet comprised of said one piece of metal, said low profile metal unitary member providing an entirely metallic thermal path for conducting heat from said first exterior

extrusion surface to a heat transfer fluid contained within said plurality of micro tubes, said member having a profile of less than approximately 0.1 inches;

an inlet end cap interconnecting the micro tube inlets in fluid communication;

an outlet end cap interconnecting the micro tube outlets in fluid communication;

said low profile metal unitary member being sealed by a first seal and a second seal for enclosing said low profile metal unitary member, said first seal being formed at said inlet end cap, said second seal being formed at said outlet end cap, said first seal forming a first seal length and said second seal forming a second seal length;

each of said plurality of microtubes being fluidly connected to adjacent and non-adjacent microtubes via said inlet end cap and said outlet end cap;

means for circulating said heat transfer fluid through said inlet end cap, the plurality of micro tubes of said low profile extrusion and said outlet end cap; and

means for removing heat from said heat transfer fluid.

22. The cooling apparatus according to claim 21 wherein:

said cooling apparatus is affixed to a printed circuit board for cooling said heat generating component.

23. The cooling apparatus according to claim 1 wherein:

said cooling apparatus is affixed to a printed circuit board for cooling said heat generating component.

24. The cooling apparatus according to claim 8 wherein:

said cooling apparatus is affixed to a printed circuit board for cooling said heat generating component.

25. The cooling apparatus according to claim 1, wherein each of said micro tubes are polygonal in cross section.

26. The cooling apparatus according to claim 1, wherein each of said micro tubes are substantially square in cross section.

27. The cooling apparatus according to claim 8, wherein said micro tubes are polygonal in cross section.

28. The cooling apparatus according to claim 8, wherein said micro tubes are substantially square in cross section.

29. The cooling apparatus according to claim 21, wherein said micro tubes are polygonal in cross section.

30. The cooling apparatus according to claim 1, wherein said micro tubes are substantially square in cross section.

31. The cooling apparatus according to claim 21, wherein said micro tubes are substantially square in cross section.

32. The cooling apparatus according to claim 1 wherein:

said member has a profile of approximately 0.1 inches.

33. The cooling apparatus according to claim 8 wherein:

said member has a profile of approximately 0.05 inches.

34. The cooling apparatus according to claim 1, wherein said micro tubes have a diameter of between approximately .0625 inches and 0.5 inches.

35. The cooling apparatus according to claim 8, wherein said micro tubes have a diameter of between approximately .0625 inches and 0.5 inches.

36. The cooling apparatus according to claim 21, wherein said micro tubes have a diameter of between approximately .0625 inches and 0.5 inches.

37. The cooling apparatus according to claim 21, wherein said low profile is approximately 0.05 inches.

38. The cooling apparatus according to claim 21 further comprising:

at least one fin on an interior surface of each of said plurality of micro tubes.